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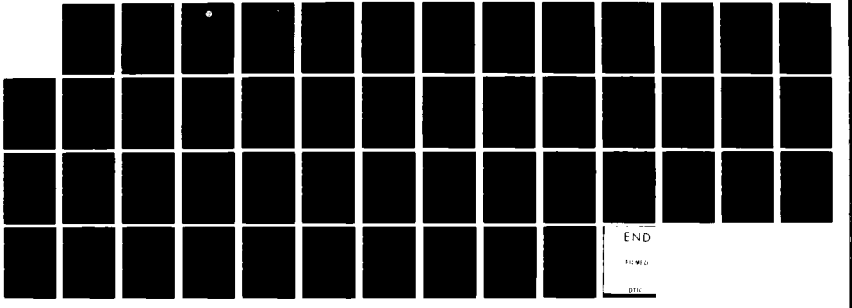

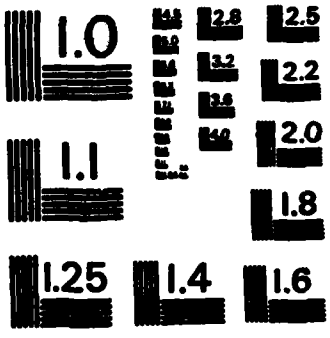

NOSC TR 734

NOSC TR 734

Technical Report 734

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NOISE LEVELS ABOARD US COMMERCIAL VESSELS AND OIL PLATFORMS

DR Schmidt

15 September 1982

Final Report: October 1980–September 1981

Approved for public release; distribution unlimited

NOSC

NAVAL OCEAN SYSTEMS CENTER
San Diego, California 92152

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ADMINISTRATIVE INFORMATION

This report describes work performed by the Airborne Acoustics Branch (NOSC Code 5134) under project USCG MIPR Z-70099-8-846490-A (NOSC 513-MB09), for the US Coast Guard, Office of Research and Development. It covers work from October 1980 through September 1981 and was approved for publication 15 September 1982.

The support of the following in the conduct of the measurements is appreciated: RS Gales, JA Hoke, and RG Klumpp. Thanks are extended to the companies which permitted measurements to be taken aboard their vessels and platforms.

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Ambient noise	Level (quantity)	Crews
Ship noise	Environments	Oil platforms
Exposure (general)	Intensity	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

To establish a data base for a US position on allowable noise on merchant vessels, NOSC was tasked by the US Coast Guard to obtain up-to-date data on noise levels on a larger and more varied sample of US vessels than reported in NOSC TR 405. This was done on sixteen vessels and five oil platforms selected from representative types available during the period February 1980 to January 1981. Vibration data were taken when possible. Data from the measured vessels and platforms are presented in this report.

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OBJECTIVES

Measure noise levels on a larger and more varied sample of US vessels and expand the data base for a US Coast Guard position on allowable noise exposure. Conduct a noise survey of oil platform noise for use in establishing a data base. Obtain vibration measurements for use in establishing standards.

RESULTS

The major sources of noise aboard 16 vessels (three work boats, two fishing boats, three tug boats, and eight passenger vessels) and five oil platforms were ship propulsion machinery and platform machinery. Forty vessel crewmen were surveyed. Of these, 22 had 24-hour duty aboard their vessels.

For unprotected ears, the crew working in ship machinery spaces had estimated 24-hour equivalent exposure levels (L_{eq24}) of 86-103 dB(A). All exposures for unprotected ears were over the Naval Ocean Systems Center (NOSC) recommended criterion for current ships of L_{eq24} = 80 dB(A). The NOSC-recommended criteria are contained in reference 2.

If hearing protection providing 20 dB(A) of protection were worn, all crewmen but six out of the 22 surveyed would meet the NOSC-recommended criterion for current ships. Of the total, only two of the four crewmen of the fishing boats would meet the NOSC-recommended criterion for new construction of 75 dB(A) for L_{eq24}.

Compartment noise levels in quarters, mess, and living areas varied widely from previously reported data. On smaller vessels, compartment levels were as high as 87 dB(A) but primarily were in the range between 70 and 80 dB(A). On larger vessels, levels were generally well below the NOSC-recommended quarters and mess level of 70 dB(A) and sleeping quarters level of 65 dB(A).

RECOMMENDATIONS

1. Implement an effective hearing conservation program by determining areas where hearing hazardous noise levels are present and instituting a noise control program within those areas to reduce source noise levels.

If noise control is not feasible:

a. Require that adequate hearing protection be worn in areas where hearing hazardous noise levels are still present.

b. Initiate an inspection program to ensure that hearing protectors are effective and have not deteriorated with use and age.

If overexposure is still present when hearing protection is worn, institute administrative controls such as duty rotation to reduce noise exposure.

2. Investigate the effect of hearing protectors on the detection of machinery malfunction cues. Nondetection of such cues could endanger vessel safety.

3. Conduct studies to determine the optimum level of noise for sleeping aboard vessels. Inadequate sleep could affect crew performance and morale.

CONTENTS

TABLES

INTRODUCTION

To add to a data base for a US position on allowable noise on merchant vessels, Naval Ocean Systems Center (NOSC) was tasked by the US Coast Guard to expand the noise level data for a wider sample of US vessels than reported in reference 1. This was done on 16 vessels selected from representative types of the US Fleet available during the period February 1980 to January 1981. These vessel data were supplemented, at US Coast Guard request, by noise level data taken on five oil-drilling platforms and by vibration data on both vessels and platforms.

PROCEDURE

Through the courtesy of US vessel owners and oil platform owners and operators, arrangements were made to take noise and vibration measurements on board. Primary emphasis was placed on measurements of the noise in work spaces, berthing spaces, messing spaces, and recreation spaces. Other areas were covered as time permitted.

Measurements were generally taken under conditions of normal cruising speed or normal operation. Seas were low or calm during all measurement periods. Drilling or nondrilling conditions for oil platforms are noted with the data.

Shipboard measurements were made in accordance with ISO 2923, Acoustics--Measurement of Noise On Board Vessels.* ISO 2923 specifies two classes of tests: type tests and monitoring tests. Type tests are performed to prove that a newly manufactured vessel corresponds to noise specifications. These require compliance with specified conditions as closely as possible. Monitoring tests (the class reported herein) are performed to check changes in noise levels that may have occurred since type tests. Monitoring tests allow some deviation from the specified conditions. Deviations from specified conditions for this series of tests were as follows:

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*Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

1. Loading conditions could not be controlled by NOSC. The ISO 2923 requirement is that ships be ballasted or fully loaded.

2. Measurements were taken primarily at cruising speed. For some ships, measurements were taken at reduced speed. These conditions are noted in the data. Measurements aboard oil platforms conformed to ISO 2923 wherever applicable.

A questionnaire was used to determine the time spent in various ship spaces by selected crew members. These times, with A-weighted sound levels taken in the spaces, were used to calculate crew duty noise exposure levels, off-duty noise exposure levels, and 24-hour equivalent noise exposure levels. Equivalent level is that level which, if continuous over a stated time period, would have the same total energy as the fluctuating levels actually occurring over the same stated time period. This is sometimes called average sound level. On some vessels, the crew did not normally spend 24 hours on aboard. For these cases, only an equivalent level for the stated work period was calculated. Equivalent levels were not calculated for oil platform workers because of inability to obtain time-in-space data due to time limitations on board.

EQUIPMENT

The instruments used to measure the noise levels were precision sound-level meters capable of taking ANSI Slow A-weight, C-weight, and octave-band levels. Instruments conformed to IEC publication R179 for precision sound-level meters and to IEC publication R225 for octave-band filters. Several Bruel and Kjaer (B&K) type 2215 precision sound-level meters equipped with B&K type 4165 ½-inch condenser microphones were used.

For vibration measurements, the microphone of the B&K 2215 was replaced with a B&K type JJ2615 adaptor and a B&K type 4332 accelerometer with magnetic mount was used as a signal source.

All instruments were calibrated before and after each noise measurement series with either a B&K type 4220 pistonphone acoustic calibrator or a General Radio model 1987 sound-level calibrator. The B&K 4220 produces a calibrate signal of 124 dB at 250 Hz, while the General Radio 1987 produces a signal level of 114 dB or 94 dB at 1000 Hz. No significant changes in calibration level were noted between calibrations conducted before and after measurement periods.

Accelerometer calibrations were performed with a General Radio model 1557A accelerometer calibrator. The 1557A produces a signal of 1 g RMS at 100 Hz. No significant changes were noted between calibrations performed before and after vibration measurements.

VESSELS AND PLATFORMS MEASURED

Vessels on which measurements were made included fishing boats, tug boats, work boats, and passenger vessels. Power plants were diesel-electric or diesel power. All ships except one were built in 1955 or later; one passenger vessel was built in the 1920s. To differentiate between vessels measured, a naming system consisting of two or three letters and a number was used. The following represents the vessel type: F = fishing boat, P = passenger, TB = tug boat, and W = work boat. The following letters represent the type of power plant: D = diesel and DE = diesel-electric. The number indicates the order of measurement in ships of a given power plant type. For example, TBD-2 represents the second diesel powered tug boat that was measured, while PDE-3 represents the third diesel-electric powered passenger vessel measured.

The 16 ships measured consisted of three diesel powered work boats, two diesel powered fishing boats, three diesel powered tug boats, four diesel powered passenger vessels, and four diesel-electric powered passenger vessels.

Information specific to the vessel measured is included with the measured sound-level data for that vessel.

The oil platforms were classified by the following scheme: OP = stationary oil platform, OI = oil production island, and DR = semisubmersible drilling rig. The number following the letters indicates the order of measurement within a platform type. Five platforms were measured, consisting of three stationary platforms, one drilling rig, and one oil island.

RESULTS

Noise measurements taken on the 16 vessels and five platforms are shown in tables 1 through 21. Vibration levels are presented in tables 37 through 48 for those vessels and platforms on which vibration measurements were taken. (Tables follow the text starting on page 15.)

Tables 1 through 21 show the spaces measured and the A-weighted, C-weighted, and octave-band levels measured in those spaces. All levels are rounded to the nearest decibel. C-weighted and octave-band levels were not measured in some spaces.

A summary/comparison of measured levels as listed in tables 1 through 21 is presented as table 22. Table 22 lists A-weighted levels in selected spaces aboard vessels and platforms. Explanatory notes give the location and other pertinent information where required. Levels were not listed for the oil platform machinery spaces because of the nonsimilarity of space and area usage. The oil platforms tend to be unique and not directly comparable in this regard. Levels are given for messing and berthing areas, where measured.

Measured levels in sleeping quarters ranged from 49 to 80 dB(A). Generally the higher levels were present on smaller vessels and the lower levels on larger vessels. The higher levels on the smaller vessels were due to lack of isolation and their proximity to the engine room.

Duty, off-duty, and 24-hour equivalent noise exposure levels were calculated from the times spent in spaces, as obtained from the questionnaire, and the measured levels (or calculated levels where noted). The equivalent level (L_{eq}) for a period of hours was obtained by (1) taking the sum of the

products of the number of hours in a space and the antilog to the base 10 of the measured level in bels in that space; and (2) dividing this sum by the total number of hours in the period for which the equivalent level is desired, and taking 10 times the logarithm to the base 10 of this quotient. The duty and off-duty equivalent levels are given so that the relative contribution of each to the 24-hour equivalent level may be noted.

Tables 23 through 36 show these equivalent levels. They also list the crew member to whom the equivalent level relates, the hours in a location, and the measured A-weighted level in that space. All levels are rounded to the nearest dB.

For crew members who work in noisy spaces such as the chief engineer (table 25), two equivalent levels are given for each 24-hour, duty, and off-duty column. The L_{eq} entries tagged by note (a) represent the exposures to be expected if no hearing protection is worn. Those tagged (b) represent exposures to be expected if hearing protectors affording 20 dB(A) of effective attenuation are worn. In the cases where the crew did not spend 24 hours on board the vessel, equivalent levels are presented for the duty period only. Examples of this are seen in tables 23, 24, and 28 - 32. The off-duty exposure was unknown in these cases. For vessels TBD-3, WD-1, WD-2, and WD-3 (tables 35 and 36) no crew exposure estimate was made because of the intermittent duty schedule which occurred on these vessels. These vessels and their crews were on an "on-call" duty status.

For the vessels FD-1 and FD-2 (tables 23 and 24), two exposures are given: one for 24-hour trips and one for nominal 10-hour day trips. FD-1 and FD-2 are fishing boats which have varied trip lengths depending on the type of charter involved. Twenty-four-hour exposures were not calculated for the day trips because of unknown off-duty exposure levels.

The accuracy of the calculated equivalent levels is based on the following assumptions: (1) the times in spaces as given by the crew are reasonably accurate, and (2) the levels measured in spaces are relatively constant and represent the noise exposures of the crew members. It was not possible, in

the short time available for the surveys, to follow crew members over a number of days so as to log their time in various spaces. With few exceptions, the stated times seemed to be good estimates in the opinion of the NOSC observers on board. The levels in machinery spaces generally were constant, varying little with ship cruising conditions. Exceptions to this occurred in smaller vessels and this is noted in the tables of measured levels for those vessels (tables 2, 3, 16-18). For the smaller vessels, an estimate of time spent at each of the cruising conditions measured was given by the crew and used to calculate a noise level which would represent the exposure under those varied cruise conditions. Readings were taken at the primary watch and/or work stations to represent the levels normally experienced by the crew.

There were 22 crewmen that had 24-hour duty on board the vessels surveyed. From these 22, for crewmen having duty in engine room spaces the range of 24-hour equivalent level exposures was from 86 to 103 dB(A) with no hearing protection worn. The spread was fairly even over this range, with no clear clustering evident. For exposures during work period only, where a 24-hour equivalent level could not be estimated, the range was from 89 to 105 dB(A), with a larger number of exposures in the range of 95 to 100 dB(A). The one deck crew member surveyed, the second mate of vessel PD-1, had a 24-hour equivalent level exposure of 65 dB(A) with no hearing protection worn. This is within the range of exposures reported for deck crew members in reference 1.

If hearing protection affording 20 dB(A) of effective protection were worn, the 24-hour equivalent levels for crewmen having duty in engine room spaces would decrease to a range of 74 to 83 dB(A). With hearing protection, 16 of the 22 would meet the NOSC-recommended criterion of L_{eq24} = 80 dB(A). No vessels except FD-1 and FD-2 would meet the NOSC-recommended criterion for future ships of 75 dB(A) for L_{eq24}. The NOSC recommended criteria for allowable noise levels and noise exposure aboard US merchant ships are contained in reference 2.

The equivalent level for work periods would decrease to a range of 70 to 86 dB(A) if hearing protection affording 20 dB(A) of effective protection were worn.

As may be noted in the tables of exposure, the amount of L_{eq24} decrease when hearing protection is worn varies. The amount of L_{eq24} decrease when hearing protection is worn depends upon the relative percentage of time spent in high noise level areas. If the time in high noise level areas is large, the L_{eq24} is decreased a greater amount than if the time is small. The high noise level exposure may dominate the total exposure, and, in these cases, the L_{eq24} difference between wearing and not wearing hearing protection approaches the effective attenuation of the hearing protector. An example of this is seen in the exposure for the two oilers and the wiper for vessel PD-1 (table 25), where the 24-hour equivalent level is decreased by 20 dB(A), the full assumed effective protection, when hearing protectors are worn.

Comments were given by the crewmen during discussions with NOSC personnel that hearing protectors were not always worn in high noise level machinery areas. One reason for not wearing them was that the protectors reduced their ability to detect machinery malfunction sounds. A common statement to back up this reason was that they "had to hear their machinery."

Vibration measurements are presented in tables 37 through 48. All acceleration levels are RMS values relative to 1 g (980 cm/s^2). Where an orientation is given, it is the relative position of the accelerometer axis to the structure or ship. For example, horizontal indicates the accelerometer is primarily measuring acceleration in the horizontal plane, while lateral indicates, for a vessel, that the measurement is taken athwartships. The octave-band levels are given only from 31 Hz to 1 kHz. Bands above 1 kHz were likely to have had incorrect levels due to resonance effects of the accelerometer and the magnetic mount. The linear level was calculated from the octave-band levels from 31 Hz to 1 kHz.

The annoyance and physical effects of vibration are a function of level, frequency, exposure time, and body orientation (ref 3). When crewmen were questioned as to annoyance due to vibration, there were no comments received as to the vibration being directly annoying. Comments on annoyance were primarily concerned with the secondary effects of the vibration - noise produced by excitation of panels and doors. In staterooms, it was common to see folded paper or wood stuffed between panels and their mounting frames to stop the noise due to vibration.

CONCLUSIONS

The major source of noise on the ships and platforms surveyed was found to be in the machinery spaces. For unprotected ears, the crew working in shipboard machinery spaces had estimated 24-hour equivalent levels (L_{eq24}) of 86 to 103 dB(A). If hearing protection affording 20 dB(A) of effective attenuation is assumed to be worn, the L_{eq24} range decreases to 74 to 83 dB(A).

If hearing protection of 20 dB(A) is worn, 16 crewmen out of the 22 having 24-hour duty on board would meet the NOSC-recommended criterion for current ships of L_{eq24} = 80 dB(A). Only crewmen on vessels FD-1 and FD-2 would meet the NOSC-recommended criterion for future ships of 75 dB(A) for L_{eq24}. Of the four crewmen surveyed on vessels FD-1 and FD-2, only two would meet the 75 dB(A) criterion. The other two, with L_{eq24} of 76 dB(A), would exceed it by only 1 dB.

All the crewmen would have an L_{eq24} greater than 70 dB(A) with 20 dB(A) hearing protection worn. L_{eq24} = 70 dB(A) is the proposed EPA criterion for exposure. This is a more stringent criterion than the one recommended by NOSC.

The one non-engine-room crewman surveyed (the second mate of vessel PD-1) had an L_{eq24} of 65 dB(A), well below the NOSC-recommended criterion of 75 dB(A), and 5 dB(A) below the EPA-recommended criterion of 70 dB(A).

All the vessels surveyed for this report were diesel or diesel-electric powered. In all cases, the diesel engines were the major source of noise contributing to noise exposure. Some vessels had quieted engine room control rooms. In many cases, however, the noise exposure obtained in areas other than the engine room control room was sufficient to cause L_{eq} exposure levels above the NOSC-recommended limits.

In general, the overall engine room levels were higher than in those vessels reported on in reference 1, which were primarily steam turbine powered. The lowest of the maximum levels in engine room spaces for this current group of measurements was 100 dB(A), with a high of 112 dB(A). The mean of these maximum readings was 109 dB(A).

For those maximum engine room measurements reported in reference 1, the range was from 99 to 108 dB(A), with a mean of 105 dB(A). These previously measured levels were also generally associated with a specific item of machinery such as a generator or reduction gear, and confined to the area around that item of machinery. In this latest survey, the high noise level caused by the diesel engines was evident over a larger area of the engine room. In some cases the noise tended to dominate the area.

Compartment noise levels in quarters, mess, and living areas varied widely from previously reported data (ref 1). On smaller vessels, compartment levels were as high as 87 dB(A) but primarily were in the range between 70 and 80 dB(A). On larger vessels, levels were generally well below the NOSC recommended levels of 70 dB(A) for quarters and mess areas and 65 dB(A) for sleeping quarters.

RECOMMENDATIONS

1. Implement an effective hearing conservation program by determining areas where hearing hazardous noise levels are present and instituting a noise control program within those areas to reduce source noise levels.

If noise control is not feasible:

a. Require that adequate hearing protection be worn in areas where hearing hazardous noise levels are still present.

b. Initiate an inspection program to ensure that hearing protectors are effective and have not deteriorated with use and age.

If overexposure is still present when hearing protection is worn, institute administrative controls such as duty rotation to reduce noise exposure.

2. Investigate the effect of hearing protectors on the detection of machinery malfunction cues. Non detection of such cues could endanger vessel safety.

3. Conduct studies to determine the optimum level of noise for sleeping aboard vessels. Inadequate sleep could affect crew performance and morale.

REFERENCES

1. NOSC TR 405, Noise Levels and Crew Noise Exposure Aboard US Merchant Vessels, by DR Schmidt, 30 April 1979

2. NOSC TD 254, Airborne Noise Limits for Merchant Ships, by RS Gales, 30 April 1979

3. J Tonndorf, HE Von Gierke, and WD Ward, "Criteria for Noise and Vibration Exposure," chapter 18 in CM Harris (ed) Handbook of Noise Control, 2d ed, McGraw-Hill, New York, 1979

Table 1. Measured Sound Levels on Drilling Rig DR-1

Location	Level re 20 micro Pa										
			--------Octave Band centered at (Hz)---------								
	A	C	31	63	125	250	500	1K	2K	4K	8K
During drilling:											
Lower Deck, Moon Pool	102	118	97	112	115	107	97	88	78	70	--
Deck Above Diesel Exhaust, 30' Away	103	117	93	112	113	108	99	89	81	--	--
Engine Room, by Operating Diesel	108	113	101	106	103	106	107	102	98	90	82
Welding Shop	86	93	82	89	88	85	83	79	79	71	62
Aux. Motor Room, At Log Desk	91	99	85	93	95	90	86	83	86	75	66
Mud Pump Room	95	104	92	98	98	95	95	87	81	75	69
Ballast Control Room	68	88	71	77	76	72	65	56	47	42	41
Windlass Control Room	87	95	67	90	90	85	71	63	50	44	40
Drillers Control Room	78	90	80	83	88	81	73	66	61	59	61
Tool Pushers Office	65	85	67	82	77	70	65	55	50	45	39
Quarters, Nearest to Engine Room	69	85	75	85	80	73	61	51	48	45	43
Recreation Room	61	77	72	78	72	63	56	51	53	45	39
Windlass Control Room	87	95	67	90	90	85	71	63	50	44	40
Hospital Room	58	75	74	68	70	61	57	50	46	43	34

Note: (--) means data not taken.

Table 2. Measured Sound Levels aboard Vessel FD-1

Location	Level re 20 micro Pa --------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge, est. 10Kn	71	87	85	82	80	75	65	65	55	50	40
Galley, est. 10Kn	75	85	80	77	80	70	73	69	64	55	56
Bunk Area	70	87	--	--	--	--	--	--	--	--	--
10 feet from stern, est. 8 Kn	90	100	83	93	93	98	85	73	65	58	55
Fillet area, est. 10 Kn	87	97	87	90	90	92	83	77	72	61	55
Engine Room, est. 9 Kn	108	111	90	98	103	107	101	105	102	93	85

Notes: (--) means data not taken

Vessel Data:
Type: Fishing Boat
Power Plant: Two Diesel Engines
Gross Tonnage Group: Less than 100
Length Group: 50-100 feet
Period of Manufacture: 1960-1965
Measurement Conditions: coastal waters, sea state 1, various speeds

Table 3. Measured Sound Levels aboard Vessel FD-2

Location	Level re 20 micro Pa --------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge, cruise	75	88	--	--	--	--	--	--	--	--	--
Cabin, (6 Kn)	77	90	--	--	--	--	--	--	--	--	--
Cabin, cruise	79	90	--	--	--	--	--	--	--	--	--
Bunk Area	67	84	--	--	--	--	--	--	--	--	--
Aft of Bait Tank, Eng. at Idle	84	96	--	--	--	--	--	--	--	--	--
Aft of Bait Tank, 6 Kn	90	102	--	--	--	--	--	--	--	--	--
Aft of Bait Tank, cruise	89	96	--	--	--	--	--	--	--	--	--
Engine Room, cruise	107	109	--	--	--	--	--	--	--	--	--

Note: (--) means data not taken

Vessel Data:
Type: Fishing Boat
Power Plant: Two diesel engines
Gross Tonnage Group: less than 100
Length Group: less than 50 feet
Period of Manufacture: 1955-1960
Measurement Conditions: inland waters, calm, various speeds

Table 4. Measured Sound Levels on Oil Production Island OI-1

Location	Level re 20 micro Pa										
			--------Octave Band centered at (Hz)---------								
	A	C	31	63	125	250	500	1K	2K	4K	8K
Steam Generator, @ 10'	85	95	95	89	88	85	77	80	75	71	66
Triplex Pumps, @ 10'	87	95	94	87	86	80	85	84	77	73	67

Table 5. Measured Sound Levels on Oil Platform OP-1

Location	Level re 20 micro Pa										
			--------Octave Band centered at (Hz)---------								
	A	C	31	63	125	250	500	1K	2K	4K	8K
During non-drilling period:											
Helicopter Deck	76	83	88	90	85	77	70	66	67	65	57
Derrick Floor	84	91	--	--	--	--	--	--	--	--	--
Prod. Deck, NE corner	90	96	85	87	89	87	85	82	84	81	69
Comp. Deck, E center	97	100	--	--	--	--	--	--	--	--	--
Comp. Deck, center	110	108	--	--	--	--	--	--	--	--	--
Comp. Deck, NE corner	98	101	87	91	93	92	87	87	93	91	84
Comp. Deck, VRU comp.	106	106	91	93	94	94	91	92	100	102	95
Comp. Deck, 1000 HP compressor	94	99	85	91	93	93	89	87	87	86	86
Comp. Deck, east of 1500 HP compressor	98	103	91	97	95	95	94	95	89	83	76
Comp. Deck, west of 1500 HP compressor	98	102	93	96	96	96	94	93	90	87	80
Boat Deck, NE corner	78	86	--	--	--	--	--	--	--	--	--
Fog Horn, 50'	111	119	--	--	--	--	--	--	--	--	--
During drilling period:											
Foreman's Office	68	85	85	78	76	73	62	62	58	49	40
Foreman's Office, bunk area	69	86	83	82	73	74	66	60	56	49	39
Galley, Prod. Deck	70	85	81	77	83	72	64	61	57	50	39
Production Office	64	82	75	72	73	67	62	59	56	51	51
Prod. Deck, SW central leg	87	95	--	--	--	--	--	--	--	--	--
Prod. Deck, Elec.room	85	90	80	81	79	87	78	79	78	73	63
Prod. Deck, Well Head	84	89	--	--	--	--	--	--	--	--	--
Prod. Deck, south side	87	95	--	--	--	--	--	--	--	--	--
Prod. Deck, above diesel exhaust	83	96	--	--	--	--	--	--	--	--	--
Prod. Deck, by "christmas tree"	85	92	--	--	--	--	--	--	--	--	--

Note: (--) means data not taken.

Table 6. Measured Sound Levels on Oil Platform OP-2

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
During production:											
Middle Deck, Aux. Comp. Room	103	107	102	97	100	101	100	98	98	91	86
Middle Deck, Compressor Room	97	102	96	93	95	97	92	92	89	89	77
Lower Deck, Air Compressor Room	94	110	108	106	100	98	88	87	83	78	73
Middle Deck, Turbine Room	108	109	103	94	99	96	98	98	101	100	100
Middle Deck, Water Inj. Room	98	104	92	102	95	93	96	94	88	81	73

Table 7. Measured Sound Levels on Oil Platform OP-3

Location	Level re 20 micro Pa										
			--------Octave Band centered at (Hz)---------								
	A	C	31	63	125	250	500	1K	2K	4K	8K
During production:											
Upper Deck, Turbine Room	106	107	94	84	94	95	100	105	99	93	90
Middle Deck, Comp. Room, Near Engine	105	110	100	100	101	104	99	96	94	104	92
Middle Deck, Comp. Room, Center	105	110	94	97	104	105	99	98	96	96	97
Middle Deck, Solar Room	96	99	88	89	90	90	93	91	91	85	85
Middle Deck, Comp. Room #2	106	106	91	93	94	93	95	95	108	102	103
Middle Deck, Generator Room	101	103	92	90	97	96	96	94	93	89	98
Lower Deck, Leg Room Three	102	100	86	92	91	92	93	92	89	84	74
Lower Deck, Leg Room Four	100	103	87	89	95	96	94	94	95	89	76
Lower Deck, Pump Room	98	101	86	85	94	95	93	90	89	75	77
Lower Deck, Outside Boiler Room	109	109	98	98	96	93	90	94	100	106	102
Middle Deck, Quarters 104, Near Top Bunk	52	80	81	75	65	52	42	30	19	15	14
Middle Deck, Quarters 104, Lower Bunk	54	82	--	--	--	--	--	--	--	--	--
Middle Deck, Quarters 104, Center	51	75	--	--	--	--	--	--	--	--	--
Middle Deck, Quarters 222, Near Top Bunk	54	83	--	--	--	--	--	--	--	--	--
Middle Deck, Quarters 222, Center	52	75	--	--	--	--	--	--	--	--	--
Middle Deck, Quarters 215, Near Top Bunk	50	77	--	--	--	--	--	--	--	--	--
Middle Deck, Rig Foremans Office	52	76	--	--	--	--	--	--	--	--	--
Middle Deck, Radio Room, At Desk	53	77	78	75	62	57	47	34	33	31	25
Middle Deck, Dining Room	59	80	--	--	--	--	--	--	--	--	--
Middle Deck, Galley, Vent Fan Operating	67	80	--	--	--	--	--	--	--	--	--

Note: (--) means data not taken.

Table 8. Measured Sound Levels on Vessel PD-1

Location	Level re 20 micro Pa										
			--------Octave Band centered at (Hz)---------								
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge, with one radar operating	60	80	79	76	55	57	55	48	46	40	37
Bridge, with two radars operating	67	80	--	--	--	--	--	--	--	--	--
Engine Room Control Room	86	99	96	93	92	87	84	79	76	71	62
Engine Room, Oiler Watch Station, Between Engines	103	106	99	98	99	99	100	97	95	91	81
Engine Room, by Operating Generator	100	105	91	91	99	101	95	94	91	93	86
Engine Room, Shaft Alley	90	100	95	96	93	89	90	86	79	74	63
Engine Room, Work Bench in Shop	88	99	96	95	93	90	87	83	78	72	61
After Steering	95	106	95	103	102	96	93	89	85	79	75
Galley, Boat Deck	75	85	80	75	78	75	73	71	68	70	53
Snack Bar Grill, Boat Deck	79	89	83	79	83	82	75	66	61	59	50
Fo'c'sle, Gallery Deck	56	82	84	77	65	57	50	49	46	39	32
Passageway, Fo'c'sle Area, Gallery Deck	71	87	86	79	82	75	64	61	52	49	36
Ch. Mate SR, Bridge Deck, forward	50	75	74	68	55	55	46	38	31	27	20
Ch. Engineer SR, Bridge Deck, fwd	49	75	77	66	57	52	45	38	36	28	25
Second Mate SR, Bridge Deck, mid	59	79	76	66	65	64	57	47	43	35	26
Third Mate SR, Bridge Deck, mid	60	78	77	74	67	66	56	47	44	37	29
Steward Quarters, Below Vehicle Deck, aft	71	87	86	85	78	72	69	60	53	45	37
Officers Mess, Boat Deck, forward	65	79	79	70	68	63	64	54	47	46	36
Crew's Mess, Boat Deck, forward	60	77	75	71	64	58	57	52	50	47	38
Steward Rec Room, Below Vehicle Deck, aft	79	90	85	86	82	78	78	74	70	62	51

Measured Sound Levels on Vessel PD-1
(Table 8 continued)

Vessel Data:
Type: Passenger
Power plant: Two diesel engines
Gross Tonnage Group: 1000-5000
Length Group: 300-350 feet
Period of Manufacture: 1960-1965
Measurement Conditions: inland waters, calm,
16.5 knot speed

Table 9. Measured Sound Levels on Vessel PD-2

Location	Level re 20 micro Pa										
			--------Octave Band centered at (Hz)---------								
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge	66	89	89	85	75	65	61	53	51	48	42
Engine Room, at Gauge Board	103	113	113	105	101	100	96	98	95	88	81
Engine Room, by Generator	102	108	104	102	102	96	97	97	94	87	81
Galley and Recreation Room	68	96	95	82	74	65	62	59	55	51	44
Ch. Engineer SR Main Deck, Forward	62	87	83	81	75	61	55	53	48	43	37
Crews Quarters, Main Deck, Forward	59	84	82	78	69	59	53	49	45	38	29

Vessel Data:

Type: Passenger
Power Plant: Two diesel engines
Gross Tonnage Group: 100-500
Length Group: 100-500 feet
Period of Manufacture: 1955-1960
Measurement Conditions: Inland waters, 3 foot seas, 10 knot speed

Table 10. Measured Sound Levels on Vessel PD-3

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge, with one radar operating	61	85	86	79	66	59	60	55	50	42	38
Bridge, window wipers operating	64	86	--	--	--	--	--	--	--	--	--
Engine Room Control Room	73	90	88	83	82	76	71	66	61	57	46
Engine Room, by Stbd. Engine	112	114	104	101	104	102	107	107	105	104	96
Engine Room, by Port Engine	112	114	104	104	108	103	107	107	105	104	95
Engine Room, by Electrical Board	108	111	99	104	102	99	103	104	102	99	89
Engine Room, Work Bench in Shop	91	104	106	96	93	87	86	87	84	81	70
After Steering	90	100	91	96	97	88	85	84	83	77	68
Galley, Observation Deck	68	85	87	77	71	64	64	63	57	53	47
Captains SR, Bridge Deck, forward	57	81	82	77	66	58	50	47	40	36	27
Ch. Mate SR, Bridge Deck, middle	58	87	90	77	65	58	54	50	45	40	44
Ch. Steward SR, Bridge Deck, aft	60	86	87	82	80	60	55	47	42	34	26
Pursers SR, Observation Deck	58	83	82	79	66	61	53	51	44	37	28
Bos'n SR, Gallery Deck, fwd	65	85	85	82	75	67	63	58	50	41	31
Jr. Engr. SR, Gallery Deck, middle	61	84	86	74	71	63	57	57	47	43	37
Cook's SR, Gallery Deck, aft	62	82	82	77	73	66	56	53	46	43	34
Crew's Mess, Observation Deck	66	82	84	76	74	66	64	60	53	46	38
Officers Mess, Observation Deck	66	85	86	79	74	66	64	62	56	47	38

Vessel Data:
Type: Passenger
Power plant: Two two-cycle diesel engines
Gross Tonnage Group: 1000-5000
Length Group: 200-500 feet
Period of Manufacture: 1975-1980
Measurement Conditions: inland waters, calm, 15 knot speed

Table 11. Measured Sound Levels on Vessel PD-4

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Wheelhouse	61	79	80	74	71	60	55	49	41	42	34
Engine Room Control Room	74	84	80	75	79	75	74	69	63	58	50
Engine Room, by #1 Diesel Engine	101	105	92	95	98	97	98	97	94	89	82
Engine Room, by #2 Diesel Engine	102	104	94	95	93	95	97	98	94	89	84
Engine Room, Work Bench	103	104	95	91	95	97	97	99	94	89	82

Vessel Data:
Type: Passenger
Power Plant: Two diesel engines
Gross Tonnage Group: 100-1000
Length Group: 150-200 feet
Period of Manufacture: 1965-1970
Measurement Conditions: Inland waters, calm, 10 knot speed

Table 12. Measured Sound Levels on Vessel PDE-1

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge	60	85	86	78	67	61	54	50	45	41	37
Engine Room Control Room	74	86	83	81	78	77	70	67	64	61	46
Engine Room, Between Engines	109	110	93	97	102	102	102	103	101	103	90
Engine Room, by Drive Motor	95	101	92	92	93	96	95	90	85	82	72
Engine Room, Work Shop	73	90	85	75	80	75	69	67	63	59	48
Engine Room, Shaft Alley	95	105	95	101	99	97	93	88	81	75	62
Engine Room, by Generator	106	108	90	96	99	100	100	100	98	99	80
Car Deck, by Engine Room Air Intakes	84	100	95	96	87	85	80	79	73	65	51
Crew SR # 1	55	90	87	70	62	56	50	47	45	37	26
Engine Room Day Room	74	87	83	84	80	77	71	67	65	65	51
Passenger Lounge	61	90	91	78	70	64	57	50	51	46	35

Vessel Data:
Type: Passenger
Power Plant: Four diesel engines, electric drive
Gross Tonnage Group: 1000-5000
Length Group: 350-400 feet
Period of Manufacture: 1965-1970
Measurement Conditions: Inland waters, calm, 16 knot speed

Table 13. Measured Sound Levels on Vessel PDE-2

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge	64	90	87	77	60	55	50	47	45	45	40
Engine Room Control Room	75	86	84	80	76	68	70	70	69	64	54
Engine Room, Between Four Engines	111	114	93	103	109	103	107	106	108	102	101
#1 Motor Room, by Drive Motor	101	106	98	103	92	88	104	86	82	80	72
Engine Room, Work Shop	80	90	85	85	79	75	73	75	73	69	52
Engine Room, Work Bench	110	114	93	101	109	104	105	105	106	100	91
Engine Room, Generator	109	113	99	104	109	103	107	105	103	98	87
Car Deck, by Engine Room Air Intakes	97	104	87	87	99	99	96	91	85	77	68
A/B Seaman SR	50	81	74	66	56	54	45	42	37	31	25
Engine Room Crew Day Room	76	89	83	81	85	75	73	70	65	59	53
Deck Crew Day Room	65	84	80	81	72	67	61	62	57	54	47
Cabin Crew Day Room	65	79	72	75	72	70	64	59	52	41	35

Vessel Data:
Type: Passenger
Power Plant: Four diesel engines, electric drive
Gross Tonnage Group: 1000-5000
Length Group: 400-500 feet
Period of Manufacture: 1970-1975
Measurement Conditions: Inland waters, calm, 16 knot speed

Table 14. Measured Sound Levels on Vessel PDE-3

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge	55	80	72	75	65	70	55	47	45	40	35
Engine Room, Gauge Board & Control	100	104	98	93	90	97	101	97	88	82	77
Engine Room, Between Engines	104	107	85	94	94	99	105	98	92	86	81
Drive Motor Area	81	90	81	85	84	83	81	75	68	61	57
Engine Room, Work Bench	87	95	85	91	90	84	87	83	76	69	61
Officer SR	58	80	77	70	67	64	59	50	40	33	21
Crew SR	51	82	72	72	60	54	50	41	32	27	18
Engine Room Crew Day Room	82	91	85	87	82	82	81	76	68	62	54

Vessel Data:
Type: Passenger
Power Plant: Two diesel engines, electric drive
Gross Tonnage Group: 1000-5000
Length Group: 250-300 feet
Period of Manufacture: 1925-1930
Measurement Conditions: Inland waters, calm, 12 knot speed

Table 15. Measured Sound Levels on Vessel PDE-4

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Bridge	55	80	85	75	65	55	50	48	45	30	35
Engine Room Control Room	82	93	85	89	86	83	84	75	69	61	52
Main Engine Room, Between Engines	110	114	89	101	105	107	111	102	95	90	83
Engine Room #2, Drive Motor	99	106	93	89	87	89	102	94	80	70	62
Engine Room #2, Work Bench	89	96	94	89	87	86	90	84	75	67	58
Main Engine Room, Reduction Gears	106	111	93	98	100	105	109	100	93	86	78
Main Engine Room, Generator	106	112	90	105	107	104	106	101	95	88	83
Captains SR	55	80	75	72	65	58	55	51	45	42	35
Crew SR	56	83	75	68	60	57	53	50	45	42	36

Vessel Data:
Type: Passenger
Power Plant: Two diesel engines, electric drive
Gross Tonnage Group: 1000-5000
Length Group: 300-350 feet
Period of Manufacture: 1955-1960
Measurement Conditions: Inland waters, calm, 13 knot speed

Table 16. Measured Sound Levels aboard Vessel TBD-1

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Pilot House, cruise	75	93	85	92	86	76	74	71	61	50	42
full power	79	97	97	95	88	79	75	72	64	55	51
Galley, cruise	83	93	88	91	85	82	80	80	73	63	58
full power	---------- Not Measured ----------										
Bow Area, cruise	78	92	84	87	88	78	76	69	59	48	40
full power	79	95	87	91	93	77	74	67	60	50	40
After Deck, cruise	78	92	--	--	--	--	--	--	--	--	--
Engine Room, cruise	109	113	101	103	110	105	106	105	101	94	91
full power	112	115	101	102	107	109	110	107	105	98	91
Lower Berthing, cruise	80	89	85	80	78	79	79	77	67	55	42
full power	---------- Not Measured ----------										

Vessel Data:
Type: Tug
Power Plant: Two diesel engines
Gross Tonnage Group: 100-1000
Length Group: 50-100 feet
Period of Manufacture: 1970-1975
Measurement Conditions: inland waters, calm

Table 17. Measured Sound Levels aboard Vessel TBD-2

Location	Level re 20 micro Pa										
	--------Octave Band centered at (Hz)---------										
	A	C	31	63	125	250	500	1K	2K	4K	8K
Pilot House, cruise	66	83	80	78	74	69	65	56	50	46	43
full power	73	92	87	91	82	73	71	61	54	51	42
Galley, cruise	73	85	81	78	81	75	73	66	59	53	45
full power	---------- Not Measured ----------										
After Deck, cruise	77	92	--	--	--	--	--	--	--	--	--
Bow Area, cruise	77	94	78	83	93	74	69	62	55	47	42
full power	83	99	91	89	97	85	71	62	53	45	38
Bunk Area, cruise	76	84	--	--	--	--	--	--	--	--	--
Engine Room, cruise	107	109	92	95	97	98	95	104	99	95	88
full power	110	113	109	102	102	100	107	106	102	98	95

Note: (--) means data not taken

Vessel Data:
Type: Tug
Power Plant: Two diesel engines
Gross Tonnage Group: 100-1000
Length Group: 50-100 feet
Period of Manufacture: 1955-1960
Measurement Conditions: inland waters, calm

Table 18. Measured Sound Levels aboard Vessel TBD-3

Location	Level re 20 micro Pa										
			Octave Band centered at (Hz)								
	A	C	31	63	125	250	500	1K	2K	4K	8K
Pilot House, cruise	73	93	90	75	70	71	70	70	64	57	57
full power	67	93	86	79	72	66	63	59	57	50	45
Engine Room, cruise	103	106	97	88	96	97	97	100	96	90	89
full power	104	107	95	89	99	101	101	100	97	92	92
Galley, cruise	83	93	92	84	85	78	79	79	73	68	70
full power	---------- Not Measured ----------										
Stern Area, cruise	71	90	88	81	82	76	71	60	54	45	39
full power	74	91	89	83	84	76	71	60	58	51	43
Berthing, cruise	69	93	87	83	76	65	67	64	58	52	48
full power	---------- Not Measured ----------										

Vessel Data:
Type: Tug
Power Plant: one diesel engine
Gross Tonnage Group: 100-1000
Length Group: 50-100 feet
Period of Manufacture: 1940-1945
Measurement Conditions: inland waters, calm

Table 19. Measured Sound Levels aboard Vessel WD-1

Location	Level re 20 micro Pa										
			Octave Band centered at (Hz)								
	A	C	31	63	125	250	500	1K	2K	4K	8K
Engine Room	103	--	--	--	--	--	--	--	--	--	--
Deck, aft of cabin	91	--	--	--	--	--	--	--	--	--	--
Main Cabin, aft	92	--	--	--	--	--	--	--	--	--	--
Main Cabin, center	86	--	--	--	--	--	--	--	--	--	--
Pilot House	80	--	--	--	--	--	--	--	--	--	--

Note: (--) means data not taken.

Vessel Data:
Type: Work Boat
Power Plant: Two Diesel Engines
Gross Tonnage Group: Less Than 100
Length Group: Less Than 50 feet
Period of Manufacture: 1965 -1970
Measurement Conditions: coastal waters, normal cruise speed, sea state 2

Table 20. Measured Sound Levels aboard Vessel WD-2

Location	Level re 20 micro Pa										
			--------Octave Band centered at (Hz)---------								
	A	C	31	63	125	250	500	1K	2K	4K	8K
Engine Room	109	110	--	--	--	--	--	--	--	--	--
Passenger Cabin, aft	90	96	90	90	87	88	85	85	83	71	58
Passenger cabin, fwd	87	95	--	--	--	--	--	--	--	--	--
Pilot House	73	87	80	80	80	75	67	67	65	54	45
Deck, aft of cabin	97	99	87	90	93	90	89	93	91	82	68
Galley/bunk, fwd	80	92	--	--	--	--	--	--	--	--	--

Notes: (--) means data not taken.

Vessel Data:
Type: Work Boat
Power Plant: Two Diesel Engines
Gross Tonnage Group: Less Than 100
Length Group: 50-100 feet
Period of Manufacture: 1965 -1970
Measurement Conditions: coastal waters, normal cruise speed, calm

Table 21. Measured Sound Levels aboard Vessel WD-3

Location	Level re 20 micro Pa										
			--------Octave Band centered at (Hz)---------								
	A	C	31	63	125	250	500	1K	2K	4K	8K
Engine room	111	114	--	--	--	--	--	--	--	--	--
After Deck, mid	88	99	--	--	--	--	--	--	--	--	--
Crew Day Cabin, mess	75	90	--	--	--	--	--	--	--	--	--
Lower Crew Cabin	78	87	--	--	--	--	--	--	--	--	--
Pilot House	78	92	--	--	--	--	--	--	--	--	--

Notes: (--) means data not taken.

Vessel Data:
Type: Work Boat
Power Plant: Three Diesel Engines
Gross Tonnage Group: Less Than 100
Length Group: 50-100 feet
Period of Manufacture: 1965 -1970
Measurement Conditions: Coastal waters, normal cruise speed, calm

Table 22. Comparison of Measured Levels in Selected Spaces

All Levels are A-weighted in dB re 20 micro Pa

Vessel/ Platform	Location							
	ER (1)	ER Cont. Room	Bridge	Off. Qtrs.	Crew Qtrs.	Off. Mess	Crew Mess	Recr. Areas
DR-1	--	--	--	--	69	--	--	61
FD-1	108	(2)	71	70	70	75	75	75
FD-2	107	(2)	75	67	67	78	78	78
OP-1	--	--	--	69	--	70	70	--
OP-3	--	--	--	53	53	59	59	59
PD-1	103	86	60/67 (3)	49	71	65	60	--
PD-2	103	(2)	66	62	59	68	68	68
PD-3	112	73	61	60	65	66	66	--
PD-4	102	74	61	--	--	--	--	--
PDE-1	109	74	60	--	55	--	--	74
PDE-2	111	75	64	--	50	--	--	76/65 (4)
PDE-3	100	(2)	55	58	51	--	--	82
PDE-4	110	82	55	55	56	--	--	--
TBD-1	112	(2)	75	80	80	83	83	83
TBD-2	110	(2)	66	76	76	73	73	73
TBD-3	103	(2)	73	69	69	83	83	83
WD-1	103	(2)	80	--	--	--	--	--
WD-2	109	(2)	73	80	80	80	80	80
WD-3	111	(2)	78	78	78	75	75	--

Notes:
(1) Maximum Engine Room level measured.
(2) Does not have Engine Room control room.
(3) With one and two radars operating.
(4) Engine room and deck day rooms.

Table 23. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel FD-1

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
24-hour Trips						
Captain	10	Bridge	71			
	2	Galley	75	(a)94	97(14)	72(10)
	3	Stern Area	89	(b)76	77(14)	72(10)
	8	Bunk Area	70			
	1	Engine Room	108			
Crewman	1.5	Bridge	71			
	2	Galley	75	(a)92	95(14)	72(10)
	12	Stern Area	89	(b)74	75(14)	72(10)
	8	Bunk Area	70			
	0.5	Engine Room	108			
Day Trips						
Captain	6	Bridge	71			
	0.5	Galley	75	(a)--	95(10)	--
	3	Stern Area	89	(b)--	76(10)	--
	0.5	Engine Room	108			
Crewman	0.5	Galley	75	(a)--	89(10)	--
	9.5	Stern Area	89	(b)--	70(10)	--

Notes: (a) L_{eq} assuming no hearing protection worn.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in spaces over 85 dB(A).
(c) Two estimated periods of exposure are given. One for overnight trips and one for "day trips". 24-hour or off-duty exposures may not be calculated for day trips.

Table 24. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel FD-2

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
24-hour Trips						
Captain	9	Bridge	75			
	1.5	Cabin	78	(a)94	96(14.5)	72(9.5)
	4.5	Stern Area	90	(b)76	78(14.5)	72(9.5)
	8	Bunk Area	67			
	1	Engine Room	107			
Crewman	2	Bridge	75			
	2	Cabin	78	(a)92	94(13.5)	72(10.5)
	11	Stern Area	90	(b)74	75(13.5)	72(10.5)
	8.5	Bunk Area	67			
	0.5	Engine Room	107			
Day Trips						
Captain	7	Bridge	75			
	2	Stern Area	90	(a)--	95(9.5)	--
	0.5	Engine Room	107	(b)--	77(9.5)	--
Crewman	0.5	Bridge	75	(a)--	90(9.5)	--
	9	Stern Area	90	(b)--	70(9.5)	--

Notes: (a) L_{eq} assuming no hearing protection worn.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in spaces over 85 dB(A).
(c) Two estimated periods of exposure are given. One for overnight trips and one for "day trips". 24-hour or off-duty exposures may not be calculated for day trips.

Table 25. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PD-1

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Second Mate	8	Quarters	59			
	2	Mess	65			
	12	Bridge	67	65	67(13)	62(11)
	0.5	On Deck	65(e)			
	1	Car Deck	65			
	0.5	Ship Spaces	65			
Chief Engineer	8	Quarters	57(1)			
	4	Mess	65			
	2	Bridge	67	(a)90	94(10)	62(14)
	4	ER Control Room	86	(b)79	83(10)	62(14)
	2	On Deck	65			
	4	Mach. Areas	98(2)			
First Engineer	8	Quarters	57(1)			
	2	Mess	65			
	0.8	Engine Room	100(2)			
	7.2	ER Control Room	86	(a)92 (b)81	95(12) 84(12)	68(12) 68(12)
	4	Mach. Areas	98(2)			
	2	Galley	75			
Second Engineer	10	Quarters	57(1)			
	2	Mess	65	(a)88	91(12)	60(12)
	1.2	Engine Room	100(2)	(b)83	86(12)	60(12)
	10.8	ER Control Room	86			
Third Engineer	10	Quarters	57(1)			
	2	Mess	65	(a)88	91(12)	60(12)
	1.2	Engine Room	100(2)	(b)83	86(12)	60(12)
	10.8	ER Control Room	86			
Junior Engineer	7	Quarters	65(3)			
	6	Mess	60	(a)87	90(11)	63(13)
	1	Engine Room	100(2)	(b)79	83(11)	63(13)
	5	ER Control Room	86			
	5	On Deck	65(3)			

Table 25. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PD-1, (continued)

Oiler	10	Quarters	65(3)			
	2	Mess	60	(a)100	103(12)	64(12)
	12	Engine Room	103	(b) 80	83(12)	64(12)
Oiler	8	Quarters	65(3)			
	3	Mess	60	(a)100	103(12)	64(12)
	12	Engine Room	103	(b) 80	83(12)	64(12)
	1	On Deck	65(3)			
Wiper	9	Quarters	65(3)			
	3	Mess	60	(a)100	103(12)	64(12)
	12	Engine Room	103	(b) 80	83(12)	64(12)

Notes: (a) L_{eq} assuming no hearing protection worn in machinery spaces.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in machinery spaces.
(1) Engine Room and quarters levels are averages.
(2) Machinery area levels are averages
(3) Estimated. In the case of crew quarters, level was estimated from passageway values. It was not possible to enter crew spaces due to 6 on/6 off watch schedule.

Table 26. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PD-2

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Chief	10	Quarters	62			
Engineer	6	Galley/Rec	68	(a)95	100(8)	65(16)
	4	Engine Room	103	(b)76	80(8)	65(16)
	4	Bridge	66			
Crewman	12	Quarters	59			
	3.5	Galley/Rec	68	(a)86	91(8.5)	63(15.5)
	0.5	Engine Room	103	(b)68	72(8.5)	63(15.5)
	4	On Deck	65(1)			
	4	Bridge	66			

Notes: (a) L_{eq} assuming no hearing protection worn in machinery spaces.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in machinery spaces.
(1) Estimated level.
(2) Vessel is used for short trips and crew either stays on board, if away from home port, or ashore. Exposure estimates are for being on board for 24 hours.

Table 27. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PD-3

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
First Engineer	10	Quarters	59(1)			
	2	Mess	66	(a)96	99(12)	61(12)
	1.2	Engine Room	109(2)	(b)77	80(12)	61(12)
	10.8	ER Control Room	73			
Second Engineer	9	Quarters	59(1)			
	2.5	Mess	66	(a)96	99(12)	62(12)
	1.2	Engine Room	109(2)	(b)77	80(12)	62(12)
	10.8	ER Control Room	73			
	0.5	On Deck	65(2)			
Oiler/ Wiper	11	Quarters	63(1)			
	1	Mess	66	(a)103	106(12)	63(12)
	6	Engine Room	109(2)	(b) 83	86(12)	63(12)
	6	ER Control Room	73			
Oiler	10	Quarters	63(1)			
	2	Mess	66	(a)103	106(12)	64(12)
	6	Engine Room	109(2)	(b) 83	86(12)	64(12)
	6	ER Control Room	73			

Notes: (a) L_{eq} assuming no hearing protection worn in machinery spaces.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in machinery spaces.
(1) Quarters levels are averages.
(2) Engine Room levels are averages.

Table 28. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PD-4

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Chief Engineer	4	Engine Room	102	(a)--	97(12)	--
	8	ER Control Room	74	(b)--	78(12)	--

Notes: (a) L_{eq} assuming no hearing protection worn in machinery spaces.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in machinery spaces.
(c) Crewmen on this vessel do not stay on board, so offduty and 24 hour L_{eq} values may not be calculated.
(d) Only one engine room personnel on watch on this vessel.

Table 29. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PDE-1

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Chief Engineer	2	Engine Room	104	(a)--	96(12)	--
	10	ER Control Room	74	(b)--	78(12)	--
Assistant Engineer	2	Engine Room	104	(a)--	96(12)	--
	10	ER Control Room	74	(b)--	78(12)	--
Oiler	1	ER Control Room	74			
	8	Engine Room	104	(a)--	102(12)	--
	1	Day Room	74	(b)--	82(12)	--
	2	On Deck	65(1)			
Oiler	4	ER Control Room	74	(a)--	101(12)	--
	6	Engine Room	104	(b)--	81(12)	--
	2	Day Room	74			

Notes: (a) L_{eq} assuming no hearing protection worn in machinery spaces.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in machinery spaces.
(c) Crewmen on this vessel do not stay on board, so offduty and 24 hour L_{eq} values may not be calculated.
(1) Estimated level.

Table 30. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PDE-2

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Chief Engineer	2	Engine Room	108			
	9	ER Control Room	75	(a)-- (b)--	100(12) 81(12)	-- --
	0.5	Day Room	76			
	0.5	On Deck	65(1)			
Third Assistant Engineer	2	Engine Room	108			
	8	ER Control Room	75	(a)-- (b)--	100(12) 81(12)	-- --
	1	Day Room	76			
	1	On Deck	65(1)			
Third Assistant Engineer	2	Engine Room	108	(a)--	100(12)	--
	10	ER Control Room	75	(b)--	81(12)	--
Oiler	5	Engine Room	108			
	3	ER Control Room	75	(a)--	104(12)	--
	2	Day Room	76	(b)--	85(12)	--
	2	Steering Room	95(1)			
Oiler	5	Engine Room	108			
	3	ER Control Room	75	(a)-- (b)--	104(12) 85(12)	-- --
	4	Day Room	76			

Notes: (a) L_{eq} assuming no hearing protection worn in machinery spaces.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in machinery spaces.
(c) Crewmen on this vessel do not stay on board, so offduty and 24 hour L_{eq} values may not be calculated.
(1) Estimated level.

Table 31. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PDE-3

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Chief Engineer	6	Engine Room	100	(a)--	97(12)	--
	6	Day Room	82	(b)--	81(12)	--
Oiler	5	Engine Room	100			
	1	ER Inspect.	99	(a)--	97(12)	--
	6	Day Room	82	(b)--	81(12)	--

Notes: (a) L_{eq} assuming no hearing protection worn in machinery spaces.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in machinery spaces.
(c) Crewmen on this vessel do not stay on board, so offduty and 24 hour L_{eq} values may not be calculated.

Table 32. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel PDE-4

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Chief Engineer	2	Engine Room	106	(a)--	98(12)	--
	10	ER Control Room	82	(b)--	83(12)	--
Oiler	10	Engine Room	106	(a)--	105(12)	--
	2	ER Control Room	82	(b)--	86(12)	--
Oiler	6	Engine Room	106	(a)--	103(12)	--
	6	ER Control Room	82	(b)--	84(12)	--

Notes: (a) L_{eq} assuming no hearing protection worn in machinery spaces.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in machinery spaces.
(c) Crewmen on this vessel do not stay on board, so offduty and 24 hour L_{eq} values may not be calculated.
(1) Estimated level.

Table 33. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel TBD-1

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Captain	10	Pilot House	79			
	8	Bunk Area	80	(a)95	98(11.5)	81(12.5)
	4.5	Galley	83	(b)81	79(11.5)	81(12.5)
	0.5	Engine Room	112			
	1	On Deck	78			
Crewmen (2)	2	Pilot House	79			
	10	Bunk Area	80	(a)98	101(11)	81(13)
	8	Deck Areas	78	(b)82	79(11)	81(13)
	3	Galley	83			
	1	Engine Room	112			

Notes: (a) L_{eq} assuming no hearing protection worn.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in spaces over 85 dB(A).
(c) There are two exposure periods - under tow (given), and intermittent docking and undocking duty. The intermittent duty is variable. No attempt will be made here to estimate such variable exposure.

Table 34. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel TBD-2

All Levels A-weighted, in dB re 20 micro Pa

Crewman	Hours	Location	Level	Equivalent Level (L_{eq}) 24 Hours	Duty(hours)	Offduty(hours)
Captain	10	Pilot House	73			
	8	Bunk Area	76	(a)93	96(11.5)	75(12.5)
	4.5	Galley	73	(b)77	78(11.5)	75(12.5)
	0.5	Engine Room	110			
	1	On Deck	77			
Crewmen (2)	2	Pilot House	73			
	10	Bunk Area	76	(a)96	100(11)	76(13)
	8	Deck Areas	77	(b)79	81(11)	76(13)
	3	Galley	73			
	1	Engine Room	110			

Notes: (a) L_{eq} assuming no hearing protection worn.
(b) L_{eq} assuming hearing protection affording 20 dB(A) of protection worn in spaces over 85 dB(A).
(c) There are two exposure periods - under tow (given), and intermittent docking and undocking duty. The intermittent duty is variable. No attempt will be made here to estimate such variable exposure.

Table 35. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessel TBD-3

No estimate of crew exposure will be made as the vessel is used for intermittent docking and undocking duty. The remainder of crew time is spent ashore or on the vessel with the engines shut down.

Table 36. Estimated Equivalent Continuous Sound Levels (L_{eq}) for Crewmen of Vessels WD-1, WD-2, and WD-3

Work schedules aboard WD-1, WD-2, and WD-3 are variable, and no single pattern of duty was obtained by questioning the captain and crew. The duty schedules are 10 hours during daytime and 14 hours at night. During these periods, vessel usage and therefore exposures are quite variable as the vessel is in an "on call" status. No exposure estimate will be made for these vessels.

Table 37. Measured Vibration on Drilling Rig DR-1

RMS Level re 1 g (980 cm/s^2)

		----Octave Band centered at (Hz)-----					
Location	Lin.	31	63	125	250	500	1K
Ballast Control Room, Horizontal	.008	*	.006	.004	.002	.003	.002
Windlass Control Room, Horizontal	.063	.004	.020	.040	.040	.013	.007
Stbd. Prop. Motor Room, Port Side, Horiz.	.008	*	.008	.002	.001	*	*
Stbd. Prop. Motor Room, Stbd. Side, Horiz.	.025	.001	.025	.008	.001	*	*

Note: (*) means level less than .001 g.
Measurments taken during drilling.

Table 38. Measured Vibration on Oil Production Island OI-1

RMS Level re 1 g (980 cm/s^2)

		----Octave Band centered at (Hz)-----					
Location	Lin	31	63	125	250	500	1K
During production period:							
Triplex Pump area, @ 10 feet	.042	.036	.018	.011	.003	.006	.007
Steam Generator, @ 10 feet	.009	.006	.004	.005	.004	*	*

Notes: (*) means level less than .001 g.

Table 39. Measured Vibration on Oil Platform OP-1

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
During non-drilling period:							
Prod. Deck, NE Leg, Horiz., N/S	.093	.007	.020	.028	.045	.040	.063
Prod. Deck. NE Leg, Horiz., E/W	.115	.006	.008	.028	.063	.045	.079
Comp. Deck, VRU Comp. Vert.	.367	.013	.020	.045	.089	.159	.316
Comp. Deck, VRU Comp. Horiz.	.211	.028	.063	.063	.112	.056	.141
Comp. Deck, west of 1500 HP Comp, Horiz.	.248	.045	.199	.063	.112	.056	.141
Comp. Deck, east of 1500 HP Comp, Horiz.	.427	.009	.050	.355	.178	.100	.100
Boat Deck, NE Leg, Horiz., N/S	.026	.004	.005	.010	.014	.014	.011
Boat Deck, NE Leg, Horiz., E/W	.024	.004	.005	.011	.014	.013	.010
Derrick Floor Support	.015	.006	.001	.001	.003	.005	.013
During drilling period:							
Prod. Deck, Well Head, Vert.	.004	*	*	*	*	*	*
Prod. Deck. Well Head, Horiz.	.003	.002	.001	.001	*	*	*
Prod. Deck, NW Cent. Leg, Horiz., E/W	.025	.005	.010	.008	.008	.013	.014
Prod. Deck, NE Cent. Leg, Horiz., E/W	.075	.006	.014	.032	.036	.040	.040
Derrick Floor Support	.015	.007	.001	.001	.002	.005	.013

Notes: (*) means level less than .001g

Table 40. Measured Vibration on Oil Platform OP-2

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Leg One, 0.5' From Inside Top, Horiz.	.178	.003	.016	.025	.100	.100	.056
Leg One, 0.5' From Outside Top, Horiz.	.003	*	.002	*	*	.001	.002
Leg Two, 5' From Outside Top, Horiz.	.003	.002	.001	*	*	.002	.001
Upper Part Leg Three, Inside, Horizontal	.199	.005	.006	.032	.040	.089	.159
Leg Three, 8' From Outside Top, Horiz.	.003	.001	*	*	*	.002	.001

Note: (*) means level less than .001 g.

Table 41. Measured Vibration on Oil Platform OP-3

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Leg One, Corner at Tank, Horizontal	.032	.003	.003	.005	.022	.014	.013
Leg Two, Corner at Tank, Horizontal	.032	.002	.004	.014	.018	.018	.009
Leg Three, Corner at Tank, Horizontal	.032	.002	.004	.016	.014	.020	.011
Leg Four, Corner at Tank, Horizontal	.040	.003	.003	.008	.020	.028	.016

Note: (*) means level less than .001 g.

Table 42. Measured Vibration on Vessel PD-1

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Stewards Rec Room, Horizontal	.638	.447	.891	.200	.141	.141	.056
Engine Room, Cont. Platform, Vert.	.083	.014	.036	.045	.045	.032	.022
Engine Room, Generator, Horiz.	.741	.016	.056	.056	.063	.199	.708
Wheelhouse, Longitudinal	.008	.007	.004	.001	*	*	*
Officers Mess, Horizontal	.005	.005	.002	.001	.002	.001	*
Forecastle, Horizontal	.032	.020	.025	.005	.002	.002	.002

Note: (*) means level less than .001 g.

Table 43. Measured Vibration on Vessel PD-3

Location

RMS Level re 1 g (980 cm/s^2)

	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Jun. Engr. SR, Gallery Deck, Mid, Long.	.033	.020	.008	.014	.007	.008	.018
Cooks SR, Gallery Deck, Aft, Long.	.039	.009	.009	.014	.005	.032	.002
Engine Room, Control Room, Vert.	.059	.022	.022.	.014	.020	.036	.025
Wheelhouse, Longitudinal	.017	.016	.005	.003	.001	*	*

Note: (*) means level less than .001 g.

Table 44. Measured Vibration on Vessel PD-4

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Bridge, Vertical	.006	.002	.004	.002	.001	.002	.003
Engine Room, Cont. Room, Vertical	.099	.008	.040	.080	.016	.023	.029

Note: (*) means level less than .001 g.

Table 45. Measured Vibration on Vessel PDE-1

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Bridge, Vertical	.018	.018	.004	.001	*	*	*
Engine Room, Control Room, Vertical	.008	.001	.003	.002	.004	.003	.005
Crew SR #1, Vertical	.009	.006	.006	.001	*	*	.002

Note: (*) means level less than .001 g.

Table 46. Measured Vibration on Vessel PDE-2

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Bridge, Horiz., Lateral	.004	.002	.002	*	.001	.002	*
Engine Room, Cont. Rm. Longitudinal	.017	.003	.010	.011	.003	.002	.005
AB Seaman SR, Horiz., Longitudinal	.003	.002	*	.002	.001	*	*

Note: (*) means level less than .001 g.

Table 47. Measured Vibration on Vessel PDE-3

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Engine Room, Gauge Board, Lateral	.058	.002	.006	.014	.013	.040	.036

Notes: (*) means level less than .001 g.
Vessel has wooden superstructure. Not possible to take vibration levels above main deck.

Table 48. Measured Vibration on Vessel PDE-4

RMS Level re 1 g (980 cm/s^2)

Location	Lin.	----Octave Band centered at (Hz)----- 31	63	125	250	500	1K
Bridge, Lateral	.017	.006	.010	.013	*	*	*
Engine Room, Cont. Rm. Longitudinal	.050	.002	.005	.005	.016	.040	.023
Captain SR, Longitudinal	.016	.010	.006	.004	.007	.007	.004

Note: (*) means level less than .001 g.